Chemical Reactivity of Lunar Dust as it Pertains to Biological Systems. E. Tranfield[1], J. C. Rask[1], C. McCrossin[1], W.T. Wallace[2], K. R. Kuhlman[3], L. Taylor[4], A. S. Jeevarajan[2], R. Kerschmann[1], D. J. Loftus[1]. [1]Space Biosciences Division, NASA Ames Research Center, Moffett Field, CA 94035 (erin.tranfield@nasa.gov); [2]Habitability and Environmental Factors Division, NASA Lyndon B. Johnson Space Center, Houston, TX 77058; [3]Planetary Science Institute, Tucson, AZ 81719; [4]Planetary Geosciences Institute, University of Tennessee, Knoxville, TN 37996.

Introduction: At NASA Ames Research Center (ARC) and Johnson Space Center (JSC), we are embarking on a program to study the biological effects of lunar dust, focusing, initially, on astronaut medical concerns. These studies include examination of the effects of lunar dust on the respiratory tract, the eye, and the skin. In addition to our focus on these organ systems, we are beginning to analyze lunar dust effects on cells. These studies are designed to reveal fundamental understanding of the response of terrestrial life to lunar dust, provide insight into how dust in the lunar environment may affect surface operations including *in situ* resource utilization, and influence designs for long term human habitation of space.

Lunar regolith is composed of approximately 50% silica, 15% aluminum oxide, 10% calcium oxide, 10% magnesium oxide and approximately 5-15% iron, depending on the location. The iron component consists of both iron oxide and metallic iron, (fully reduced iron), a form of iron that is not present in terrestrial minerals. Lunar regolith is formed and modified by continuous micrometeorite impacts on the lunar surface. The high velocity impacts cause localized vaporization of the lunar regolith which quickly recondenses on surrounding regolith resulting in agglutinates with high surface area, complicated shapes, and sharp jagged edges. In addition, the lunar regolith is continuously bombarded by solar wind, consisting predominantly of hydrogen, helium and electrons. Solar wind effects, together with ultraviolet (UV) radiation from the sun, are predicted to modify the surface chemistry of lunar regolith, leading to free radical formation and other changes, which may enhance the chemical reactivity.

The Challenge: Unfortunately, the Apollo era samples have been contaminated by oxygen and water vapor from the ambient air with the result that the chemical reactivity of lunar regolith, as it existed on the lunar surface, has been lost. Since the chemical reactivity of lunar regolith may be the most important feature that determines its interaction with biological systems, terrestrial experiments must include reactivation of lunar dust in order that valid toxicology studies can be performed. Fundamental biological studies of the interaction of lunar regolith with biological systems also require that the issue of chemical reactivity be addressed.

Strategies for reactivating lunar regolith may include exposure to hydrogen and helium plasmas, UV exposure, proton bombardment sources, and mechanical grinding. Work in these areas is ongoing at NASA and the Planetary Science Institute. A difficulty that we face, however, is that critical measurements of the chemical reactivity of lunar regolith were never carried out at the time that lunar regolith was first obtained. As such, it is not possible to compare the reactivation methods we are using with a known measure of the chemical reactivity of pristine lunar dust.

A Potential Solution: At ARC and JSC, we have been using a simple chemical assay to evaluate the chemical reactivity of lunar regolith (1). The assay measures the potential for surface radicals on lunar regolith to generate hydroxyl radicals upon exposure to water. The assay involves the conversion of terepthalate (non-fluorescent) to hydroxy terepthalate (fluorescent), in the presence of hydroxyl radicals. Hence, simple fluorescence detection systems can be used as an indicator of surface radicals on lunar regolith. In the laboratory, this assay provides us with a method for evaluating different techniques of lunar regolith re-activation, as well as a method for characterizing the decay (passivation) of this re-activated state in an environment containing oxygen and water.

To fully validate our re-activation methods, we need to use pristine lunar regolith to calibrate the terepthalate assay. To this end, we have designed an instrument, LunaChem, that can be delivered to the lunar surface as a secondary payload, so that an analysis of lunar regolith can be performed using the terepthalate assay *in situ*. LunaChem includes a robotic arm for acquisition of lunar regolith, microfluidics for reagent dispensing, and optical components for measuring fluorescence. The results of *in situ* analysis of lunar regolith chemical reactivity will clarify critical issues pertinent to lunar dust toxicology, and will provide fundamental understanding of the interaction of biological systems with lunar regolith.

(1) W.T. Wallace, L. Taylor, B. Cooper, and A.S. Jeevarajan, Earth Planet. Sci. Lett. (2008) submitted.